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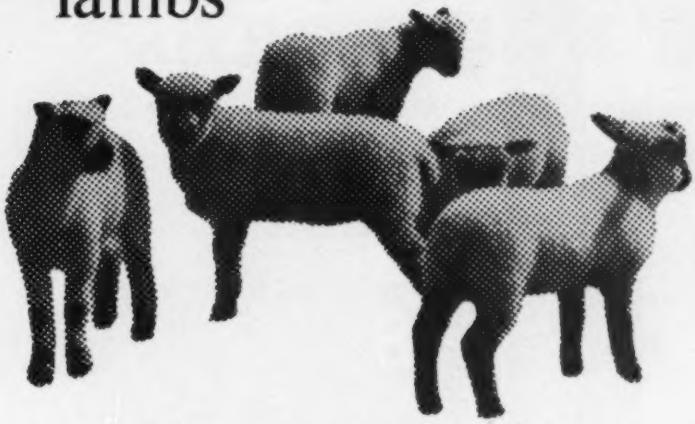

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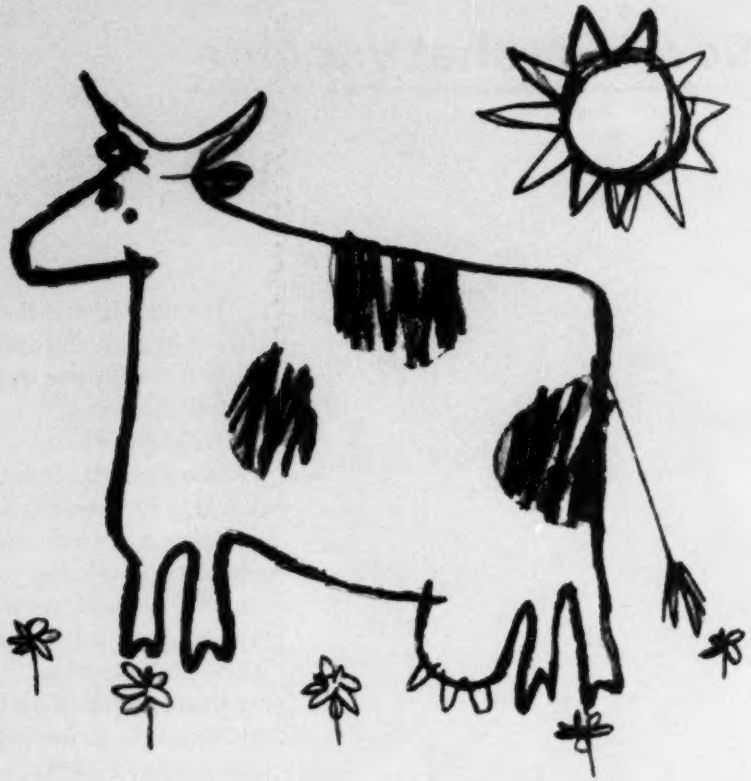

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AFRICAN HORSE SICKNESS

The 1959-60 Epizootic of African Horse Sickness in the Near East Region and India, and a Note on Technical Assistance Provided by the Food and Agriculture Organization of the United Nations

By N. R. Reid

Food and Agriculture Organization of the United Nations

Horse sickness is well known in South Africa, where it has been the subject of a great deal of research at the Onderstepoort Veterinary Laboratory by Theiler, Alexander and others. The disease is common in East and West Africa and in Egypt where it is now considered to be enzootic. East of Suez horse sickness has seldom been recorded, although serious outbreaks took place in Palestine, Syria, Lebanon and Transjordan during the Second World War.

The purpose of the present article is not to provide any detailed account of the disease, which appears to conform closely with the classical picture as seen in southern Africa, and of which Henning in his book "Animal Diseases in South Africa" provides an excellent description. The intention is rather to provide an example of technical assistance on an international scale and also to show the development of mutual co-operation between countries faced by a disastrous epizootic.

EPIZOOTIOLOGY

As mentioned above, the disease occurs in Egypt and in 1958 a few cases were noted in the Red Sea region of Saudi Arabia. On the mainland of Africa the disease is common in Ethiopia. The present epizootic appears to have started in the summer of 1959 in the Persian Gulf region of Iran and it may have been introduced by the clandestine importation of equine species from Africa. No definite evidence on this point is available. However, horse sickness was almost certainly carried northeastwards and northwestwards by the nomadic herds; it appeared during the late summer of 1959 in Iran, Afghanistan and Pakistan. There was uncertainty in the diagnosis at first, the disease being confused with equine influenza.

Specimens submitted from Afghanistan to Onderstepoort in November 1959 proved negative, although veterinarians there first made the tentative diagnosis of horse sickness from the clinical picture. A positive diagnosis was confirmed later in material submitted to Onderstepoort in spring 1960 from Pakistan; in Iran a similar diagnosis was made at about the same time. With the onset of summer the epizootic spread westwards into Iraq and then swept northwards along the Tigris and the Euphrates into Turkey and Northern Syria.

In Iran it moved into the region bordering the Caspian Sea. Later in the year it appeared in Cyprus (September), Lebanon (October) and Jordan (October). On the east it crossed the Thar desert into India in May 1960, spreading rapidly eastwards to Bihar and Orissa, and southwards to Bombay. In Pakistan the epizootic spread relatively slowly, being held up by the strict quarantine and stamping-out measures enforced. In Afghanistan, after a lull of several months, the disease reappeared in July 1960 in the eastern and central regions and was threatening to spread to the valuable horse-breeding country to the north and thence to U.S.S.R.

Mortality figures have been put at between two and three hundred thousand but no accuracy can be vouched for these.

With the onset of winter the epizootic has subsided in all countries except India. Here cases are still prevalent in Marasthra State and presumably the insect vectors are continuing to breed and to transmit the disease. Here one may anticipate a flare-up in the summer. What the position is likely to be in other countries where the disease has now disappeared is difficult to foretell. According to South African workers, it is unlikely that animals which recover remain carriers from one season to another. It has generally been maintained that some undiscovered reservoir provides the source of a fresh outbreak. Whether such a link exists in countries of the Near East is impossible to say. It can only be remembered that the disease "carried over" the winter of 1959/60 and also that frost which normally kills the vector is absent in the warm climates of this area.

PATHOGENICITY

From investigation at Onderstepoort, Alexander states that the Asian strain of the virus is not identical with any of the South African strains, although it approximates to one (No. VI) of the seven strains incorporated in attenuated form in the polyvalent Onderstepoort vaccine.

The Asian strain is at present undergoing passage through mice to bring it to a sufficient stage of attenuation to permit of its incorporation in the vaccine.

The Asian strain is highly virulent for horses and over 90 per cent of those showing symptoms die (in India the percentage was lower). Mules are less severely affected (50 per cent) and donkeys seldom. The position in regard to donkeys is somewhat confusing. A few cases and deaths have been noted in India but in general they appear to resist infection. However, in Cyprus where a vaccination campaign of all equine species was started with the object of eradicating horse sickness, donkeys reacted severely and 5 per cent died. Apart from the severe loss, this poses the problem as to whether these animals should be included in the establishment of "immune buffer belts". And what of other animals which can be artificially infected, such as the goat and dog? To the best of our knowledge these animals (particularly the dog) have been moved from Africa to other continents without any spread of horse sickness.

Fig. 1. Horse affected with African Horse sickness showing oedema of lips, supraorbital fossae, jaw, chest and lower abdomen. (By permission of the Food and Agriculture Organization of the United Nations).

Fig. 2. Horse affected with African Horse sickness showing oedema of conjunctiva, lips, submaxillary region and face (By permission of the Food and Agriculture Organization of the United Nations).

Knowledge of the vector in this epizootic is lacking. It is thought to be *Culicoides* spp. but proof is lacking, although the Virus Research Laboratory at Poona has carried out some experimental work in this field.

The disease has shown a tendency to "hop" over long distances, as exemplified by its spread from Quetta in West Pakistan over the desert to Jaipur in India, a matter of a thousand miles. The appearance of horse sickness in the island of Cyprus, without any detected importation of equine species, is alarming. In these instances there does not appear to be any association with aircraft.

CONTROL MEASURES

In the early stages of the epizootic countries depended on the use of quarantine and in certain places, notably Pakistan, on the removal of sources of infection by the destruction of clinical cases. To this was added the spraying of stables and the washing-down of animals with insecticides. It was soon realized that, alone, these measures would not be sufficient to halt the epizootic or to give protection to the valuable equine populations.

When it was realized that the Asian virus was antigenically different from the strains incorporated in the polyvalent vaccine prepared in South Africa, it became a matter of urgency to test the South African vaccine before recommending its wholesale use. With the collaboration of the Government of South Africa, the services of an experienced research worker, Dr. P. G. Howell, were made available to the Food and Agriculture Organization (F.A.O.) in July 1960. Arrangements were made with the Razi Institute in Teheran for the vaccination and challenge tests to be carried out. This proved that the South African vaccine gave satisfactory protection and countries were advised to make use of it as extensively as possible. F.A.O. assisted in obtaining some 100,000 doses for different countries in the region.

At the same time, with the active participation of the Iran Government, a training centre was organized for the diagnosis of horse sickness and vaccine production at the Razi Institute, Onderstepoort making available the seven attenuated vaccine strains. About 20 veterinarians from six countries attended. The Razi Institute had already started vaccine production and with some assistance supplies rapidly became available. By September 1960 25,000 doses per week were being issued. This polyvalent vaccine is reported to have given excellent protection.

In Turkey a formolized inactivated spleen and gland vaccine was prepared from slaughtered clinical cases and about 150,000 doses were used. Detailed reports on results have not been received but apparently the vaccine at least gave a temporary immunity which safely carried the animals over the danger period.

In August 1960 F.A.O. convened a meeting of countries of the region at Beirut to consider what other measures should be taken to combat the epizootic. There was an urgent demand for assistance in obtaining supplies of vaccine and for vaccine-production units to be established in infected countries. In view of the fact that the disease had probably become established in the region,

and as the costs of South African vaccine were considerable when used in wholesale immunization campaigns, the setting up of these production units in the region seemed to be most important as a long-term policy. Furthermore, this fitted in with Technical Assistance Board philosophy, which is directed towards helping countries to help themselves.

The Chairman of the United Nations Technical Assistance Board responded immediately to requests for funds and some 180,000 U.S. dollars were made available from the Contingency Fund in September. Visits were then paid to the different countries to find out what the requirements were in terms of experts, equipment and mice. Dr. Haig, virologist, from Kenya, spent six weeks training staff in Turkey. In addition, three countries—Turkey, Afghanistan and Pakistan—took advantage of the Expanded Technical Assistance Programme to include virologists in their 1961 requirements. It should be emphasized that the countries themselves are doing the job and F.A.O. assistance is only provided to fill in some of the more serious deficiencies and to ensure co-ordination. By the end of the year the Razi Institute in Iran was producing 25,000 to 30,000 doses of vaccine per week, Cairo 10,000, India 5,000, and Turkey 5,000. Preparations to get into production were going ahead in Greece, Pakistan and Afghanistan.

As it is a mouse-brain vaccine, the building up of large colonies of mice is necessary for vaccine production. Roughly, a mouse-breeding colony of 1,000 males and females produces 1,000 mice for inoculation per week, which gives 7,000 doses of vaccine. Many laboratories are lacking in experience and facilities, so a mouse expert, Mr. A. A. Tuffery, was recruited and paid visits to Turkey, Afghanistan and Pakistan. Foundation colonies of mice were given by the United Kingdom to Turkey and by Kenya to Pakistan. If all goes well, by April 1961 the eight laboratories in the affected zone should be capable of producing a total of 500,000 doses per month. This should largely meet the infected countries' main requirements for the summer of 1961.

FUTURE ACTION AND THE DANGER OF SPREAD OF THE DISEASE

In the west there is a definite threat that the disease will spread to the Bosphorus and across into the Balkans and the Mediterranean countries. To guard Europe, therefore, urgent action is needed to inoculate the equine population of a million in the west of Turkey, Greece and the Greek islands, and southern Bulgaria. On the vast northern frontier, there is imminent danger of horse sickness spreading into Soviet Russia on the common borders of Turkey, Iran, Afghanistan and Pakistan, particularly Afghanistan. To the east the disease is on the eastern seaboard of India and threatening Assam and Eastern Pakistan. To the south there is Ceylon and Arabia.

When this position was brought to the notice of the F.A.O. Council in November 1960, the Secretariat was directed to convene a meeting immediately in collaboration with the Office International des Epizooties (O.I.E.). This meeting was held in Paris in January 1961; some 31 countries attended and

considered not only the threat from African horse sickness but also the disastrous invasion of African swine fever into Spain and Portugal.

The main recommendation about horse sickness is for the immediate establishment of large buffer zones of immunized animals between the infected and the free zones. There is no doubt that the countries concerned would expand vaccine production to meet the demand—provided that facilities and funds are made available to pay for this vaccine.

Already the United Kingdom has responded by promising a mouse expert for the region and supplies of mice and equipment are to be flown in. It is expected that other countries will also contribute. F.A.O. is hoping to organize once again assistance from international agencies, but the calls are particularly heavy on this source at present.

RESEARCH ON HORSE SICKNESS

Tribute should be paid to the great assistance rendered by the Onderstepoort Laboratory in diagnosing and typing the virus, in supplying vaccine during the emergency and in making available the attenuated strains for the laboratories in Asia. It is, however, essential that research should be carried out within the region. Horse sickness has an unhappy knack of producing "new" strains of virus and causing "breakdowns" of immunity. Facilities for research are required to deal with these problems and also those of the vector.

The Special Fund of the United Nations has approved a project for an animal health institute in the Near East region. In this it is planned to establish, in joint co-operation with the countries concerned, five separate sections in five national veterinary laboratories within the region. These sectional laboratories will serve as centres of research and training, and for the manufacture of certain biological productions. A unit at the Razi Institute in Iran will be for African horse sickness and it is hoped to establish this early in 1961.

In addition, the national laboratories are themselves initiating programmes of research. It is proposed that this regional research should as far as possible be co-ordinated under the general advice of the F.A.O./O.I.E. Near East Committee on Animal Health, which will meet in Ankara in June 1961. At that time the joint F.A.O./O.I.E. meeting on "Emerging Diseases" will be convened and the present epizootic of African horse sickness will be reviewed once more.

CONCLUSION

The epizootic which has raged through Asia in the past year and a half has in some countries caused severe direct losses through the deaths of horses and mules. Indirectly it has caused a considerable dislocation of farming operations.

It remains an immediate threat to Europe, Soviet Russia and the Far East. Through the agency of modern transport systems, no country is safe from the disease, as presumably the vector may survive journeys by aircraft.

Efforts have been made through F.A.O. and O.I.E. to get countries together to co-operate in stemming the tide of this invasion. It is indeed a pleasing

feature, in a world split by political differences, to have veterinarians of all nationalities harmoniously discussing plans for the better control of this livestock disease. Whether they will be successful will largely depend on the practical and continuing response to the appeal for technical assistance.

Reference

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(*Received for publication*, 8 *February*, 1961)

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DETERMINATION OF THE CARDIAC OUTPUT OF CATTLE AND HORSES BY THE INJECTION METHOD

By E. W. Fisher and R. G. Dalton
Department of Medicine, University of Glasgow Veterinary School

The determination of the cardiac output gives a direct indication of the ability of the heart to maintain the circulation. A number of methods have been devised to make this critical determination, some, such as the thermostromuhr and the cardiometer, being applicable to experimental animals only, while others have been devised for use on the intact, unanaesthetized subject. These latter methods include the use of X-rays and measurement of heart size in systole and diastole, ballistocardiography, the Fick method, and the injection method. Of all these methods only the Fick method and the injection method have been used in the larger domestic animals.

The Fick method, by which the cardiac output is determined from the amount of oxygen absorbed or carbon dioxide excreted by the lungs per minute, requires the measurement of both ventilation rate and the concentration of oxygen or carbon dioxide in arterial and true mixed venous blood at the time that the ventilation rate is being measured. This method is unsuitable for use in adult cattle and horses if face masks are used for the measurement of ventilation rate. It has been shown in ruminants (Dougherty, 1960) that eructated rumen gases are inhaled and reabsorbed in the lung; thus ventilation measurements made with a face mask would be in error, transfers from rumen to lung via the pharynx being unrecorded. The use of face masks in horses would decrease the number of animals on which determinations could be made since few horses will tolerate face masks for the length of time (one minute at least) required for accurate measurement of ventilation rate (Fisher, 1961) without becoming excited. This would invalidate the normality of any determination of cardiac output made under these conditions. This difficulty can be overcome in both species by tracheotomizing and recording ventilation through a tracheotomy tube, but this procedure would limit the number of animals available on which determinations could be made.

The injection method on the other hand requires only the injection of a suitable non-diffusible intravascular indicator into the venous circulation and the collection of serial arterial blood samples for a short period afterwards in order to follow the passage of the indicator through the heart. The cardiac output is calculated from the equation:

$$\text{Cardiac output} = \frac{60 \times I}{ct}$$

where I = amount of dye injected;
c = mean concentration of dye;
t = time for one passage of dye through the heart.

Derivation of Equation

Consider, for example, water flowing from a pipe at a constant rate. To find the rate of flow it is necessary to collect and measure the outflow for a specific time.

$$\text{Flow per minute} = \frac{\text{Volume of outflow} \times 60}{t \text{ seconds}}$$

If there is no accurate method available of measuring this volume it is possible to determine it by adding to it a known amount (I) of a substance which will mix completely with this volume of water and, after they have mixed, finding the concentration of this substance. The volume can then be found from the equation:

$$V = \frac{I}{c}$$

Subsequently in the flow equation:

$$\text{Flow per minute} = \frac{I \times 60}{ct}$$

To consider the example of the pipe again—if a known amount of an indicator is injected into the flow and the passage of the indicator I is followed at some point distal to the injection site by the removal of serial samples, then it will be found that the mean concentration passing this point will be the same as the mean concentration of the collected volume. Furthermore, the time taken to pass this point will be the same as the time taken to fill the volume V containing the indicator at concentration c. By constructing a graph of serial indicator concentrations against time on semi-logarithmic paper as illustrated in Fig. 1 it is possible to find the mean concentration c and the time t for the passage of the indicator. Thus by serial sampling it is possible to find V from $V = \frac{I}{c}$ and also flow from $F = \frac{I \times 60}{ct}$

The volume of outflow from the heart within the circulation cannot be measured directly, but the passage of indicator can be followed by adopting a procedure analogous to that described above by taking serial arterial samples, studying the time course of the passage of indicator past the sampling point and from this finding the mean concentration c and the time t for one circulation of the indicator through the heart.

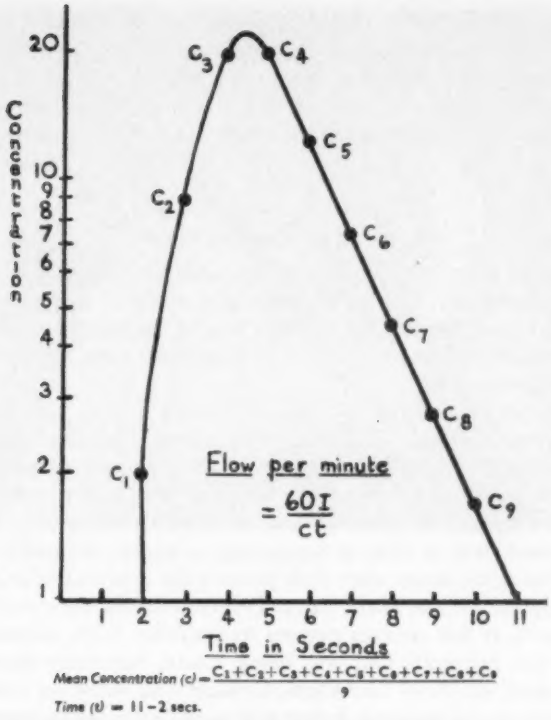

Fig. 1. Indicator time–concentration curve.

The cardiac output can then be calculated from the equation:

$$\text{Cardiac output} = \frac{60\,I}{ct}$$

Many intravascular indicators have been used for the determination of cardiac output by the injection method, including [^{131}I]albumin, sodium chloride, Fox green and Evans blue. Evans blue has been used to a greater extent than others but suffers from the disadvantage in the human of "blueing" the subject. In recent years, too, many dye-dilution recorders have been developed to facilitate the determination of cardiac output, and in the human subject ear-pierce oximeters have been used to eliminate arterial puncture. However, opinions are divided on the value of the various dye-dilution recorders and ear-pierce oximeters (Dow, 1956).

Techniques had been developed for obtaining, by percutaneous puncture, arterial blood samples from cattle (Fisher, 1956) and horses (Fisher, 1959). Both of these techniques have been used on many subjects with very little disturbance of the animal and have been shown, by means of subsequent post-mortem examinations, to cause no internal damage.

Determinations were made of the cardiac output of a number of adult cattle and horses using Evans blue as the intravascular indicator. Dye-dilution recorders and ear-pierce oximeters were not used, partly because of the controversy surrounding them and partly because it would have been necessary to carry out additional development procedures in order to use them in horses and cattle.

MATERIAL AND METHODS

All animals used in this study, so far as could be ascertained clinically and electrocardiographically, had no abnormalities of their cardiovascular systems. The cattle varied in weights from about 100 kg. to 600 kg. and in age from about nine months to adult dairy cows. The latter were in various stages of lactation and pregnancy.

The horses used were mainly heavy draught horses but determinations were also carried out on one garron, one hunter and some thoroughbreds.

It was realized that it was not possible to have either horses or cattle in the basal conditions prescribed for the determination of the cardiac output of the normal resting human subject. However, standard conditions were adopted so that the animal was as close to the resting condition as possible. All animals were allowed to settle down after their journey for a period of at least 20 hours and frequently for two or three days. Determinations were carried out in a quiet room with as few persons present as possible. Each animal was within stocks while the determination was being made, but these particular stocks merely prevented excessive backward, forward and sideways movement. The animals were haltered and the halter was held by an experienced and quiet attendant.

In order to facilitate the injection of Evans blue a nylon catheter about 15 cm. in length was inserted into the jugular vein. An area over the jugular furrow was clipped, sterilized with Cetavlon solution (Imperial Chemical Industries Ltd., Wilmslow, Cheshire) and then infiltrated with a 5 per cent solution of procaine hydrochloride. After waiting a few moments for the local anaesthetic to act, venipuncture was effected using a 2 in. No. 12 B.W.G. needle. Once the vein had been entered a 20 cm. length of 1·5 mm. diameter nylon rod was put into the vein through the needle and the needle was removed. A 15 cm. length of 4 Gauge Portex nylon rod (Portex Tubing—Portland Plastics Ltd., Hythe, Kent) was then inserted. In this manner it was possible to place in the vein a catheter of similar diameter to the venipuncture needle and to obviate the use of a very large needle. The skin then fitted tightly around the catheter. A 5 cm. length of flexible rubber tubing was connected to the nylon catheter. The rubber tubing and nylon catheter were filled with heparinized saline and then closed with a Mohrs clip. A cow with such a catheter *in situ* is shown in Fig. 2.

At the same time the area at the root of the neck through which percutaneous puncture of the brachial artery was later effected was also clipped, sterilized and infiltrated with about 10 ml. of 5 per cent procaine hydrochloride using

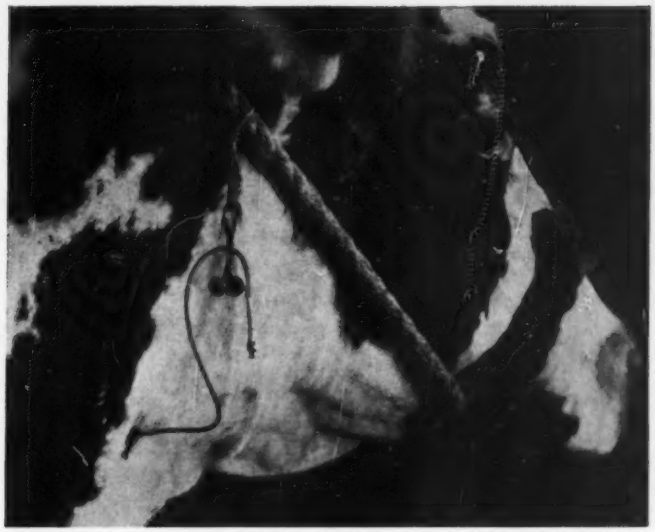

Fig. 2. Venous catheter *in situ*.

Fig. 3 (a). Arterial puncture *in situ* (cow).

Fig. 3 (b). Arterial puncture *in situ* (horse).

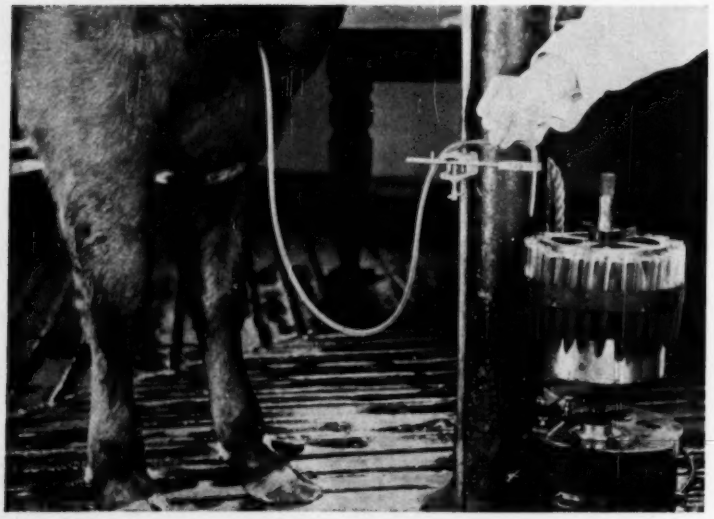

Fig. 4. Collection of serial arterial blood samples.

a No. 19 B.W.G. needle 2 in. in length in order to anaesthetize deeper tissues. The animal was then left undisturbed for about one hour.

Just prior to the actual injection of Evans blue, puncture of the brachial artery was effected at the sites shown in Fig. 3. About 40–60 ml. of blood was collected for the preparation of dye-blood and dye-plasma standards.

The Evans blue solution injected was of a concentration of 20 mg./ml. in normal physiological saline. The volume injected varied with the body weight and was of the order of 1 ml./50 kg. body weight. The amount of dye was accurately determined by weighing the syringe containing it immediately before and after injection.

The dye was injected into the jugular vein through the nylon catheter and the catheter was cleared with normal physiological saline so that all the dye entered the circulation. This double injection procedure was carried out in less than four seconds by means of a special Y piece with Leuer-lock connections and minimal dead-space. Checks on this Y piece showed that after the injection of dye and the succeeding wash with saline less than 0·1 mg. of dye remained in the Y piece.

Collection of the serial arterial blood samples was started immediately after the dye was injected. The serial arterial samples were collected in a number of heparinized centrifuge tubes which were arranged around the rim of a 6 in. diameter kymograph drum. The speed of the kymograph was regulated so that each tube collected blood for a specific time. The time per tube for cattle was one second and for horses two seconds. Such a collection is illustrated in Fig. 4. After all the tubes had collected blood the arterial collection was stopped and the needle in the artery removed.

During injection and collection, the pulse rate was counted by auscultation or more often by using a single-lead electrocardiogram. On many occasions, 10 minutes after injection of Evans blue a blood sample was taken from the brachial artery where possible, or from the opposite jugular vein to the one through which the dye was injected for the determination of plasma and blood volume. About half an hour after injection and collection the animal was taken back to its loose-box or stall.

The serial arterial blood samples were numbered, and centrifuged and the plasma was separated. From the blood collected prior to injection 20 ml. volumes were accurately measured and to each volume was added sufficient of the 20 mg./ml. Evans blue solution to make standards in which the dye concentration was either 10 mg. or 20 mg. per litre of blood. These were then mixed, thoroughly centrifuged and the plasma separated.

Comparisons were made between the readings of the plasma of the serial arterial blood samples and the plasma of the standards using an E.E.L. photo-electric colorimeter with a No. 607 Ilford Filter (Evans Electroselenium Ltd., Harlow, Essex). A graph was plotted on semi-logarithmic paper of the colorimeter readings of the serial arterial blood samples against time. The descending limb of the dye-dilution curved so obtained was extrapolated to the base line as shown in Fig. 5. It has been shown that the curve so produced is what would be expected if there were no circulation of dye such as occurred in the body

and which produced the secondary rise shown. From this curve was found the time for one complete circulation of the dye and the mean concentration of the dye.

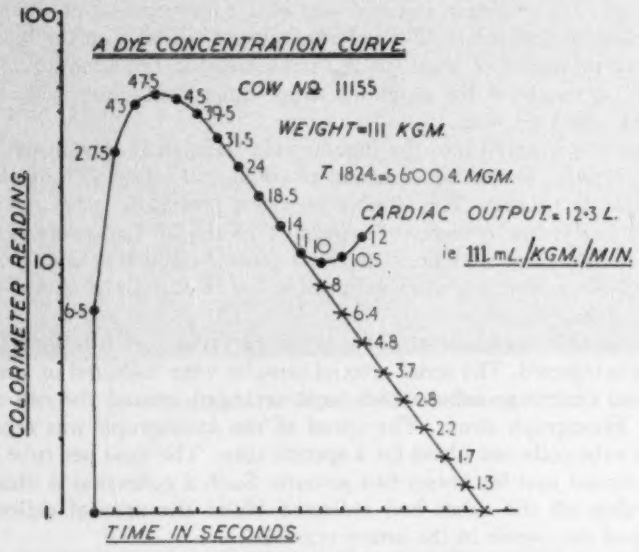

Fig. 5. Dye-dilution curve, normal cow.

The cardiac output was calculated from the equation:

$$\text{C.O.} = \frac{60 \times \text{amount of dye injected}}{\text{mean concentration} \times \text{time for one circulation}} = \frac{60I}{ct}$$

RESULTS

Thirty cardiac output determinations were made on 20 cows and heifers in Glasgow and three determinations were carried out on three adult cows in Philadelphia, U.S.A.

Twenty determinations were made on ten adult horses in Glasgow, these animals being mainly of the heavy draught type, and four determinations were made on thoroughbred horses in Philadelphia.

Calculations were made of the cardiac outputs as litres per minute and also as millilitres per kilogram body weight per minute. These results are given in Table I for cattle and Table II for horses.

TABLE I

CARDIAC OUTPUT DETERMINATIONS IN CATTLE

Expt. No.	*Cow No.*	*Body weight (kg.)*	*Cardiac Output*	
			(l./min.)	*(ml./kg.body weight/min.)*
1	11155	111	12·3	111
2	11123	201	22·0	110
3	11123	201	26·0	129
4	A	209	25·0	121
5	12234	314	32·0	102
9	12284	330	40·0	121
6	12248	342	39·0	114
7	11693	344	42·0	122
8	12284	350	37·0	106
10	10987	360	48·0	133
11	10985	361	34·0	94
12	12317	365	43·0	115
13	P.P.P.	371	40·0	108
14	12701	380	44·0	116
15	12450	387	37·0	96
16	J.C.	392	48·0	122
17	G.I.	404	48·0	119
18	T.19	420	56·0	133
19	11523	424	52·0	123
20	11523	433	48·0	111
21	B.22.	472	48·0	102
22	12282	482	53·0	110
23	12282	482	60·0	124
24	T.14.	486	62·0	128
25	S.7.	495	58·0	117
3	P.3.	500	60·0	120
26	S.1.	505	51·0	101
2	P.2.	514	54·0	105
27	E.10	515	49·0	95
28	77057	528	55·0	104
29	S.4.	534	67·0	125
30	S.8.	595	58·0	97
1	P.1.	650	65·0	100
Mean		407·7	45·8	113
S.D.				±11·33

TABLE II

CARDIAC OUTPUT DETERMINATIONS IN HORSES

Breed	Identification no. of horse	Weight (kg.)	Cardiac output (l./min.)	Cardiac output (ml./kg.body weight/min.
			24	64
Garron	1	373	25	67
Thoroughbred	Ph.3.	384	30	78
Thoroughbred	Ph.4.	465	41	88
Thoroughbred	Ph.2.	466	35	75
Thoroughbred	Ph.1.	500	40	80
			36	71
Arab X hunter	2	509	40	79
			40	75
Clydesdale	3	534	37	69
			39	69
Clydesdale	4	562	42	73
			35	62
Clydesdale	5	568	38	67
			60	94
Clydesdale	7	636	57	90
			47	69
Clydesdale	8	683	56	82
			35	71
Clydesdale X	9	760	51	67
			70	89
Clydesdale	10	786	56	71
Mean		560	43·7	75
S.D.				±8·668

DISCUSSION

The results of the determination of the cardiac output of cattle are similar to those obtained by Doyle, Patterson, Warren & Detweiler (1960) for the cardiac output of six adult cows and are also similar to the results for the cardiac output of calves reported by Stowe & Good (1960).

The results for the resting horses were similar to those reported by Zuntz & Hagemann (1898). No significant difference was found between the cardiac outputs of draught horses and the other types of horse. When the various species of domestic animals on which determinations of cardiac output have been made are compared on a body weight basis, similar values are found in sheep (Schambye, 1952), goats (Barcroft, Boycott, Dunn & Peters, 1919) and cattle. Horses have a much lower cardiac output when at rest and so has man in the basal state (Cournand, Ranges & Riley, 1942), although non-basal values for man are somewhat higher (Wood, 1958). Values reported for the cardiac output of dogs are also much higher (Marshall, 1926). These species differences in cardiac output are given in Table III.

TABLE III

COMPARISON OF CARDIAC OUTPUT OF DIFFERENT SPECIES

Species	*Outputs (ml./kg. body weight/min.)*	*Authors*
Cattle	113	Present study
Cattle	99	Doyle *et al.*, 1960
Calves	123	Stowe & Good, 1960
Sheep	113	Schambye, 1952
Sheep	100	Cross, Dawes & Mott, 1958
Goats	120	Barcroft *et al.*, 1919
Horses	75	Present study
Horses	75	Zuntz & Hagemann, 1898
Human (basal)	85	Cournand *et al.*, 1942
Human (non-basal)	122	Wood, 1958
Dogs	138	Marshall, 1926

SUMMARY

The technique of the determination, by the injection method, of cardiac output of adult cattle and horses is described. A mean value of 113 ml./kg. body weight/min. was found for the cardiac output of 29 cattle and a mean value of 75 ml./kg. body weight/min. was found for the cardiac output of 14 horses. Comparisons are made with similar determinations carried out by other authors in the same species and with determinations carried out in other species of domestic animals and the human subject.

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SEASONAL FLUCTUATIONS IN THE WORM EGG COUNTS OF SHEEP IN SOUTHERN RHODESIA

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Two systems of sheep management exist in Southern Rhodesia. The first, where sheep are grazed on improved (possibly irrigated) pastures in a tobacco ley, might be designated the "intensive" system. This intensive system is characterized by a high rate of stocking. The second system, where sheep are herded on large areas of natural pastures, may be designated the "extensive" system.

The problem of internal parasitism in sheep is one of the most serious problems the sheep breeder has to face. It is unlikely that it will ever get out of hand under systems of extensive management, but there is every possibility that it will become serious under intensive management.

MATERIAL AND METHODS

Animals

Two flocks under the two different systems of management were kept under observation for two years.

Flock B (intensive system) consisted of 48 Wiltshire horn, Blackhead Persian cross-bred ewes (wiltipers) in 1958, and 100 of this breed in 1959. Faeces samples were taken at weekly intervals from 12 of these ewes.

Flock G (extensive system) consisted of 100 Blackhead Persian ewes, and faeces samples were taken at weekly intervals from 20 of the ewes.

Grazing Management

Flock B was rotated on 12 one-acre paddocks of irrigated star grass at 3–4-day intervals. They thus returned to graze the same pasture every 6–7 weeks.

Flock G was run under conditions typical of the majority of farm flocks in Rhodesia. They were rotated on eight areas of natural pasture at half-weekly intervals during the rainy season (November to May) and at weekly intervals during winter.

During the two winters both flocks received supplementary feeding. Flock B received (in addition to running on an irrigated pasture which showed very little growth) hay *ad libitum* and four ounces of whole maize per head per day from April to November. Flock G received hay *ad libitum*, four ounces beef meal per head per day during 1958 and two ounces beef meal per head during winter 1959.

Anthelmintic Treatments

Flock B received phenothiazine every three weeks throughout the two-year period, with the exception of a period one month before and one month after lambing. In July 1958 tetrachlorethylene was given instead of phenothiazine.

Flock G had been receiving alternate dosings with phenothiazine and tetrachlorethylene every three weeks until 16 June, 1958. Thereafter these drugs were given at irregular intervals.

Faecal Egg Counts

The technique used was that described by Gordon & Whitlock (1939) modified only by the use of a magnetic stirring apparatus. Four cells were counted from each sample.

RESULTS

The mean egg counts per gram of faeces of both groups of sheep are shown graphically in Figs. 1 and 2.

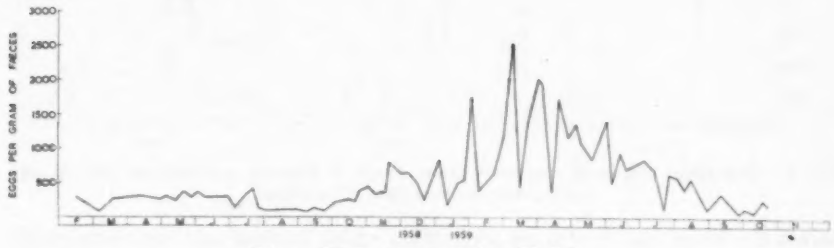

Fig. 1. Worm egg counts from Flock B.

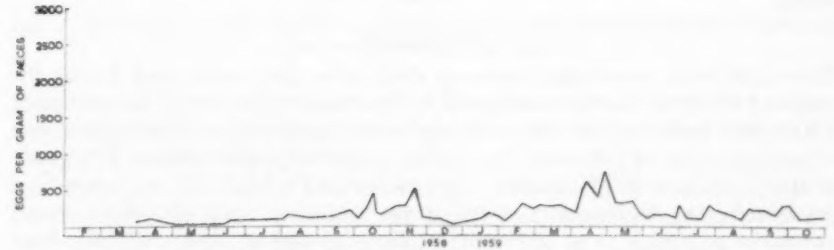

Fig. 2. Worm egg counts from Flock G.

Since the number of sheep observed is small, the mean egg count shows a marked variation for the early months of 1959 (Fig. 1). However, if the behaviour of individual sheep is considered (Fig. 3), it is seen that after parturition a definite rise in egg count occurs, the interval between parturition and the peak of egg output being about 20 days.

The rise in egg count in April 1959 in Flock B (intensive system) was because seven ewes lambed out of the 12 on which observations were made. Fig. 4

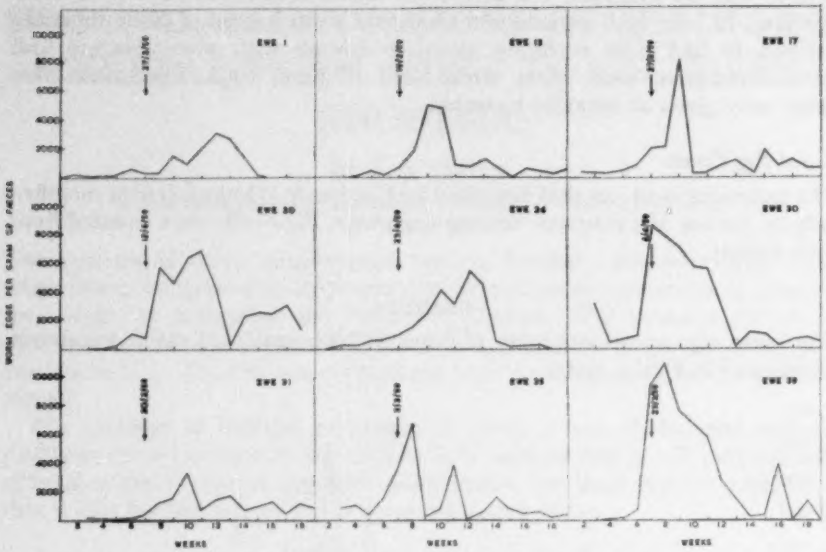

Fig. 3. Individual graphs of nine ewes from Flock B showing post-partum rise in egg count. Arrows show date of lambing.

shows the mean counts of these seven ewes which lambed and five ewes which did not lamb.

In October 1959 nine lambs (born March 1959) from Flock B were slaughtered. On post-mortem examination no parasitic nematodes were found.

DISCUSSION

The variation in worm egg counts on sheep from day to day and during the course of a day have been investigated by Spedding (1952, 1953), and although it has some shortcomings the worm egg counting technique remains the most valuable method of following the activity of the helminth burdens in a group of sheep. Hunter & Quenouille (1952) examined statistically the worm egg count sampling technique and found the optimum time interval between successive samplings to be one week. Thus, as a routine, weekly samples were taken. Both flocks were on a very high plane of nutrition throughout the period of observation and were subjected to the minimum of stress.

It is interesting to note that Flock G, in spite of having only three doses of anthelmintics within a period of 18 months, never showed a mean egg count of over 1,500 eggs per gram. This may be explained either by the fact that they were rotationally grazed over a large acreage, never grazing the same pasture for more than three days in summer and seven days in winter and consequently

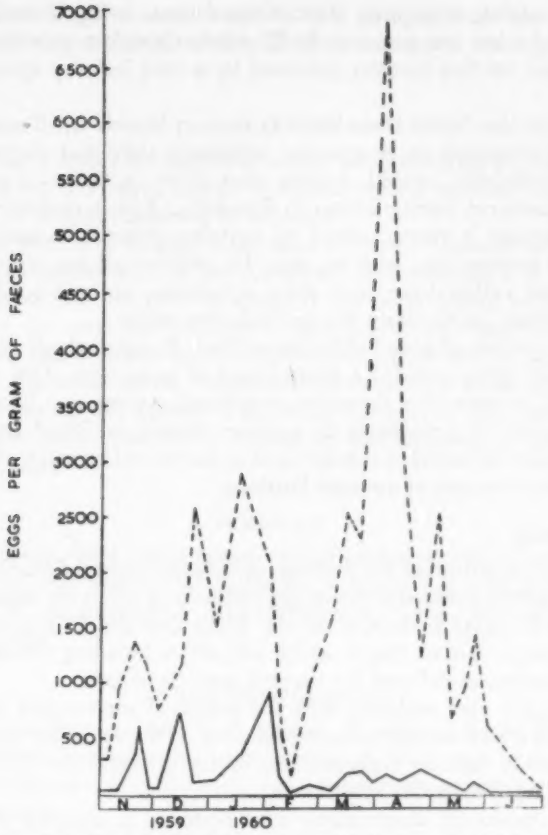

Fig. 4. Rise in egg count in Flock B in April 1959. Broken line, ewes which lambed; continuous line, ewes which did not lamb.

acquiring few infective larvae, or to the fact that in the previous year (1957), before observation had begun, a substantial experience with parasites left them with considerable resistance.

It must be noted that both a "spring rise" (Morgan & Sloan, 1947; Morgan, Parnell & Rayski, 1950; Morgan, 1951) and a post-partum rise (Spedding, 1956; Crofton, 1958) occurs in Southern Rhodesia.

Larval Intake

Morgan & Sloan (1947), Morgan *et al.* (1950) and Parnell, Dunn & McIntosh (1954) have all shown the "spring rise" in Scotland to be due to an increase in the worm burden due to larvae acquired at that time; these authors found no evidence that larvae were lying dormant in the mucous membrane of the abomasum throughout the winter. The climates of Scotland and Rhodesia

are almost complete opposites, that of the former being characterized by a wet winter and a less wet summer. In Rhodesia there is a very dry winter with little or no rain for five months, followed by a very hot dry spring and a wet summer.

The fact that nine lambs from Flock B, born in March-April and slaughtered in October, harboured no nematodes (although they had never been dosed with an anthelmintic) would suggest that there is little or no persistence of larvae on pastures during winter in Rhodesia. This is understandable since the winter climate is characterized by extreme desiccation and early spring is a period of intense heat with no rain. In addition all but irrigated pastures are brown and rather bare, and these conditions are not conducive to the survival of larvae, particularly the pre-infective stages.

Worm egg counts of nine lambs from Flock B, aged about eight weeks on 22nd February 1960, revealed a mean count of 4,949 eggs. This worm burden was acquired in spite of a three-day rotational system and illustrates that a heavy infestation of nematodes in summer lambs in Rhodesia may occur. Circumstantial evidence that this fact is of importance is given by Kotze (1958), who advocates a system of autumn lambing.

Effect on Immunity

Soulsby (1957), confirming the findings of Stewart (1950), described an inverse relationship between seasonal worm egg counts and antibody titres, and agreed with Crofton's (1954) postulates on the point that the falling immune status will pass through various stages which will allow invading larvae to establish themselves, but to be delayed for varying periods of time.

Soulsby (1957) also considers that the principal mechanism causing loss of resistance is the lack of adequate stimulation of the immune apparatus, with secondary factors such as malnutrition, severe climatic conditions and pregnancy operating within this framework.

From the results of observations in Rhodesia, it appears that the most significant rise in worm egg output occurs just after lambing, and that this rise occurs irrespective of season. To interpret this rise adequately is difficult, but it appears that the stress of lambing is the most important factor in reducing the immune status of sheep, and that it is a more important cause of loss of resistance than lack of adequate stimulation of the immune apparatus.

Post-partum Rise

Parnell *et al.* (1954) showed the parturition had a marked influence on the time of onset of the spring rise. Spedding (1956) also showed that the time of lambing (and nutritional level) had an influence on the onset and magnitude of the spring rise.

Crofton (1958) presented evidence to support the view that a rise in egg output occurs 6–8 weeks after parturition, and that this rise is unrelated to season.

From the results shown above it seems that the most important and significant rise in worm egg output occurred at 27 days post-partum in Flock B and at

43 days in Flock G. The mean length of the rise, i.e. from the time the egg counts started rising to the time they levelled out again, was 33 days in both flocks.

CONCLUSIONS

Since prevailing weather conditions in winter are unsuitable for larval survival, it appears that it is advisable, subject to adequate food supplies being available, that a system of autumn lambing be adopted.

The present system of putting ewes onto a "clean" pasture to lamb cannot altogether be recommended as the maximum contamination of pasture with nematode eggs occurs just *after* lambing. A low-level dosing of phenothiazine in the form of one part phenothiazine: nine parts salt, supplied to the ewes during lambing time, should do much to reduce infestation in lambs.

It is also concluded from the results of observations on Flock G that a three-day grazing rotation can greatly reduce the dangers of internal parasites in sheep managed under conditions typical of the majority of farm flocks in Southern Rhodesia.

SUMMARY

Two flocks of sheep, kept under intensive and extensive systems, were observed over a period of two years. The variations in faeces egg counts are discussed in relation to management and treatment with phenothiazine and tetrachlorethylene.

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THE EFFECT OF FEEDING A HIGH OR A LOW MINERAL CONCENTRATE ON THE INCIDENCE OF KETOSIS IN DAIRY COWS

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In recent studies on a dairy herd with a high level of ketosis (Blackburn, Castle & Strachan, 1958; Blackburn, Castle, Drysdale & Strachan, 1959*b*) a number of different feeding treatments were shown to have no effect on the incidence of the disease. The feeds given in the experimental treatments were largely grassland conservation products and cereals grown on a small acreage under a system of intensive management (Castle, 1960). In general the amount of inorganic fertilizer applied to the crops was large, and from the results of grassland manurial trials at this Institute with similar amounts of fertilizer (Stewart & Holmes, 1953; Castle & Holmes, 1960) it could be presumed that the conditions were such as to have a marked effect on the mineral content of the feeds. The various experimental rations used in previous trials were composed of different home-grown feeds but the calculated mineral intakes on these rations were very similar and generally at a low level. As a result, on some treatments the intake of certain minerals was below the optimum level for normal lactation (Evans, 1960). Skamser & Proewig (1958) have suggested that a low sodium content of pastures may be a factor in ketosis and they have indicated also that added magnesium may be helpful in treatment. Shaw (1956) has noted that whereas supplements of phosphorus, copper and cobalt did not prevent ketosis, no instance of the disease occurred when alkali-treated straw was fed.

The regular onset of ketosis in a herd of spring-calved cows being fed on conserved grass products has prompted this investigation of the effect of a high and a low mineral concentrate on the incidence of ketosis.

EXPERIMENTAL METHODS

Cows

Seventeen Ayrshire cows which had calved between 15 February and 29 March, 1959, were divided into two groups, containing eight and nine animals, so that the cows in the two groups were as similar as possible in age, date of calving, live weight and potential milk yield. The eight cows in the first group had completed an average of 5·6 lactations with a mean yield of 882 gallons of milk in the last lactation, whilst those in the second group had completed 5·1 lactations and yielded 860 gallons.

Feeding

All 17 cows received the same basic maintenance ration. Up to three weeks before calving this consisted of 40 lb. grass silage, 20 lb. fodder-beet and 7 lb. hay per day, whereas after this time until the end of the experiment on 16 April the amount of silage was reduced to 30 lb./day and the hay replaced by 9 lb. dried grass. In addition to this basic ration one group (nine cows) was fed a high mineral concentrate mixture whilst the other group (eight cows) was fed a low mineral concentrate mixture. The low mineral concentrate consisted of (all parts by weight) four bruised oats, two ground barley, one flaked maize, one soya bean meal, half grass meal, half locust bean meal, half groundnut cake and half tic beans. The high mineral concentrate was basically similar apart from the replacement of three-quarter part of soya bean meal by three-quarter part white fish meal and the addition of 35·7 lb. of a mineral supplement (Minsal Fortified No. 3) to each 1,000 lb. of the concentrates. Details of these concentrates and the other feeds are given in Table I.

TABLE I

CALCULATED FEEDING VALUES AND MINERAL CONTENT OF THE BASIC FEEDS AND CONCENTRATE MIXTURES

	High mineral concentrate	*Low mineral concentrate*	*Silage*	*Fodder-beet*	*Dried grass*	*Hay*
Dry matter (%)	83·9	83·5	19·7	16·6	86·4	82·5
Percentage of dry matter						
Crude protein	19·5	18·4	8·4	7·8	11·7	10·2
Approximate starch equivalent	70	70	50	60	56	35
Approximate digestible crude protein	15·6	14·8	5·1	4·7	7·0	5·1
P	0·69	0·41	0·28	0·16	0·32	0·27
Ca	0·96	0·15	0·41	0·15	0·31	0·37
K	0·80	0·90	2·41	1·69	3·36	1·97
Na	0·48	0·01	0·16	0·47	0·15	0·21
Mg	0·34	0·17	0·15	0·19	0·14	0·11
Trace elements in dry matter (p.p.m.)						
Mn	200	38	94	76	136	144
Co	8·6	0·4	0·4	0·4	0·5	0·3
Cu	81·0	31·9	11·8	16·0	14·9	14·2
Mo	8·3	2·3	5·3	0·1	0·7	3·9

All the basic feeds together with 65 per cent of the concentrate mixture were grown on one farm. The hay, silage and dried grass were all produced from leys which received heavy artificial fertilizer applications and in which very little clover was present. The hay was cut at the early flower stage but was subjected to fairly severe weathering. The silage was made entirely from fairly long, leafy material but again weather conditions were not favourable to good silage-making. The dried grass was made under better conditions. All these feeds were weighed in bulk daily during the experiment and divided carefully between the cows.

The silage was fed at 7.00 a.m., the fodder-beet at 12 noon and the hay or dried grass after the evening milking.

The two concentrate mixtures were fed at the same rate to both groups and before calving all cows received a "steaming-up" ration of approximately 200 lb. of concentrates. On the day after calving 8 lb. of concentrates were offered to each cow and this was increased by 2 lb. per day until 14 lb. per day was being fed. This weight was kept constant until the 15th day when the concentrates were fed at the rate of 4 lb. for every 10 lb. milk after the first 5 lb./day. The amount of concentrates fed was never allowed to fall below 14 lb./day. The concentrates were mixed mechanically on the farm under well-controlled conditions in 10 cwt. batches and samples were taken from each new batch, generally once a week. The fodder-beet was sampled twice a week, the hay and dried grass once a week from a daily bulked sample, and the silage every day. The dry-matter content of each sample was determined and crude protein analyses done on weekly bulked samples. A detailed mineral analysis for both major and trace elements was made on these bulked samples.

Housing, weighing and milking

The cows were housed indoors during the experiment but were allowed exercise in a bare paddock for two hours daily. The cow and calf were weighed within 12 hours of calving and thereafter the cows were weighed weekly. Milk yields were recorded at each milking time, i.e. twice per day.

Blood samples and analysis

Samples of blood were taken from each cow weekly for six weeks before calving and until the end of the experiment. The total acetone bodies were determined in each sample by the method of Thin & Robertson (1952).

Rothera's test

Samples of milk taken at each evening milking from every cow were subjected to a controlled Rothera's test to detect ketones. According to the colour reaction obtained these milks were graded (−), or +1, +2, +3, +4, or +5.

Therapeutic treatment of cows

For the purposes of the experiment it was decided to treat therapeutically any cows when a Rothera's test in the milk of +3 or higher was attained. This was necessary on 14 occasions during the experiment and two different methods of treatment were used. Five cows in the high mineral group and four in the low mineral group were given potassium chlorate at a rate of 2 oz. per day for three days. The second method was by intramuscular injection of 200 mg. of prednisolone trimethyl acetate (Ultracortenol, CIBA) (Vigue, 1958), and two cows in the high and three in the low mineral group were so treated. Thus seven cows were treated in each group.

Dates

The experiment lasted from 2 January to 16 April, 1959.

RESULTS

Feed consumption

A number of minor illnesses caused some variation in feed intake but there was no consistent inappetance during the experimental period. However, during the last two weeks of the trial, just before grazing started there was a general inappetance which could not be correlated with ketosis and which disappeared when the cows went out to pasture.

The daily intakes of feed nutrients and minerals calculated for cows yielding an average of 45 lb. milk per day are given in Table II.

TABLE II

MEAN DAILY INTAKE OF FEED NUTRIENTS AND MINERALS ON THE TWO CONCENTRATE MIXTURES FOR COWS YIELDING 45 LB. MILK/DAY

	Intake from			*Total intake*	
	Basic feeds	*High mineral concentrate*	*Low mineral concentrate*	*High mineral treatment*	*Low mineral treatment*
	Groups 1 & 2	*Group 1*	*Group 2*	*Group 1*	*Group 2*
Feed nutrient (lb.)					
Dry matter	17·0	13·4	13·4	30·4	30·4
Starch equivalent	9·3	9·4	9·4	18·7	18·7
Digestible crude protein	1·0	2·1	2·0	3·1	3·0
Major elements (g.)					
P	21·7	42·0	25·0	63·7	46·7
Ca	24·2	58·5	9·2	82·7	33·4
K	208·8	48·7	54·8	257·5	263·6
Na	16·4	28·7	0·6	45·1	17·0
Mg	11·8	20·7	10·3	32·5	22·1
Trace elements (mg.)					
Mn	848	1,217	231	2,065	1,079
Co	2·8	52·0	2·3	54·8	5·1
Cu	109	493	194	602	303
Mo	16·9	50·5	14·2	67·4	31·1

The dry matter, starch equivalent and digestible crude protein intakes were virtually identical for both groups, but there were marked differences in nearly all the mineral intakes. Those of sodium, calcium, phosphorus and magnesium showed increases varying from 36 to 165 per cent on the high mineral treatment. The intake of potassium was the same for both groups but this element was initially high in the low mineral concentrate. The trace element fraction was doubled in the high mineral treatment in respect of the manganese, copper and molybdenum fractions and was very much higher for cobalt. These intake figures mean that whereas the low mineral treatment tended to supply below the recommended daily requirements for calcium and sodium and was low in respect of phosphorus, cobalt and magnesium, the high mineral mixture was more than adequate (Evans, 1960; Maynard and Loosli, 1956).

Rothera's test

The grading of the milk samples from the two experimental groups according to the controlled Rothera's test is tabulated in Table III.

TABLE III

NUMBER OF SAMPLES OF EVENING MILK FROM THE TWO GROUPS OF COWS WHICH WERE POSITIVE TO ROTHERA'S TEST

	Rothera's test reaction					
	+1	+2	+3	+4	+5	*Total*
Treatment						
High mineral concentrate	28	35	9	0	0	72
Low mineral concentrate	34	22	12	6	0	74

These results have been adjusted because of the unequal number of cows in the two groups and are expressed in Table III on the basis of eight cows per group. The total number of positive tests in each group was similar although the low mineral group contained more samples with +3 and +4 reactions than the high mineral group.

Blood ketones

The values obtained for the ketone content of the blood are given in Table IV, and are similar to the pattern obtained in previous years (Blackburn *et al.*, 1958; Blackburn *et al.*, 1959*b*). Even before calving the ketone levels of both

TABLE IV

AVERAGE CONTENT OF KETONE BODIES IN THE BLOOD OF THE COWS IN THE TWO GROUPS (MG. ACETONE/100 ML.)

	Days before calving						*Days after calving*					
	42–36	35–29	28–22	21–15	14–8	7–0	0–7	8–14	15–21	22–28	29–35	36–42
High mineral concentrate												
Mean value for nine cows	10·6	13·9	9·4	9·4	10·3	10·0	12·1	12·7	20·7	12·2	12·4	10·6
Low mineral concentrate												
Mean value for eight cows	14·8	11·8	16·4	9·2	10·4	7·5	12·8	23·6	15·6	9·1	13·7	6·6

groups were relatively high. The mean values for the six weeks before calving for the high and low mineral groups were 10·6 and 11·7 mg. respectively; the corresponding figures for the six weeks after calving were 13·4 and 13·6 mg. This similarity between groups existed, also, in the weekly comparisons, apart from the second week after calving when the low mineral group had a mean ketone content of 23·6 mg. compared with 12·7 mg. in the high mineral group. This was largely attributed to one cow in the low mineral group which had a very high level of 65·8 mg.

When the level of ketones in the blood was used as an indication of the degree of ketosis (Thin & Robertson, 1953) the 17 cows were grouped as shown in Table V.

TABLE V

THE 17 COWS GROUPED ACCORDING TO THE MAXIMUM VALUE OF KETONE BODIES IN THE BLOOD FOR THE 6-WEEK PERIOD AFTER CALVING

	Type of ketosis			
	Severe	*Mild*	*Sub-clinical*	*Normal*
	Ketone bodies (mg.acetone/100 ml.)			
	>60	59–30	29–10	<10
Treatment				
High mineral concentrate (9 cows)	Nil	3	3	3
Low mineral concentrate (8 cows)	1	2	5	Nil

This method of assessment indicates a slightly greater prevalence of ketosis in the low mineral group, but these are purely arbitrary divisions and when they are studied in conjunction with Table IV it is clear that there were no important treatment differences.

Clinical symptoms of ketosis

No major differences in clinical symptoms between the high and low mineral concentrate groups were observed. In fact, the general ketotic symptoms of lethargy, anorexia, emaciation and hard faeces were rare. The overall picture was of a sub-clinical ketosis where a moderately high ketone content of the blood and milk was detected, accompanied by a persistent drop in milk yield, irrespective of the feeding treatment. The immediate treatment of cows when a milk sample gave a +3 Rothera's test probably prevented more severe symptoms in some cows, but each group was treated similarly in this respect.

Milk yield

The mean daily milk yield per cow during the first eight weeks of lactation was 42·5 and 44·8 lb. for the high and low mineral concentrate groups respectively. The presence of abnormal amounts of ketone bodies in the milk or the blood was invariably accompanied by a drop in milk yield, and, as the incidence of ketosis was similar for both groups, the reduction in milk yield would also be expected to be similar. These decreases in milk yield were always observed where a positive Rothera's test was found and showed that even sub-clinical levels of ketosis had a marked depressing effect on the initial phase of lactation.

Results of treatment

On 14 different occasions treatment was begun when the Rothera's test gave a reading of +3 or higher. The nine treatments using potassium chlorate resulted in a very significant rise in milk yield, which was always accompanied by negative reactions to the Rothera's test within four days of treatment. The results of that aspect of the work have already been reported (Blackburn, Castle & Drysdale, 1959*a*). The remaining five treatments with prednisolone

trimethyl acetate were much less effective in producing a response in milk yield and on the fourth day after treatment the milk in all instances was positive to the Rothera's test. In previous trials using ketotic cows many conventional treatments had been tried without success and it is noteworthy, therefore, that potassium chlorate was so effective in producing a lasting result.

The average length of time which elapsed between calving and the occurrence of a Rothera's test reaction of +3 in the milk was 18 days.

Live weights

Both groups were very similar in live weight. The mean weights were 1,095 lb. and 1,092 lb. for the high and low concentrate groups respectively during the first week after calving, and 1,015 lb. and 1,006 lb. during the sixth week. Calf weights also showed no important differences between the groups, the respective calf weights for the high and low mineral groups being 78 and 73 lb.

DISCUSSION

A type of ketosis which has resulted in substantial milk yield losses without any marked clinical symptoms being shown has been a problem for some years in a herd of spring-calved cows. As stated earlier it was thought that this disease might be related to the mineral composition of the ration and to investigate this matter two rations were fed in the trial, one supplying minerals at a low level which for some elements was below the recommended level for milk production (Evans, 1960), and one at a high level where the supply was more than adequate. On each treatment the basic diet was composed of conserved grass products which had a low mineral content and each ration supplied adequate dry matter, digestible crude protein and an excess of starch equivalent.

As in previous years a high incidence of ketosis was detected, and 14 of the 17 cows in the experiment were affected with either clinical or sub-clinical symptoms of the disease as indicated by blood and milk ketone tests. The three cows which were classed as normal (Table V) were all on the high mineral concentrate treatment. Blood samples were, however, only taken once a week and it is felt that the results of the blood ketone values should be considered along with the results of the Rothera's tests which were done daily. From these results (Table III) it will be seen that both groups gave a similar number of positive reactions but that the high mineral concentrate treatment gave half the number of highly positive reactions (+3 and +4) given by the low mineral treatment. This smaller incidence of ketosis on the high mineral ration is not, however, of great significance when the general high incidence of the disease in both experimental groups is considered. The average milk yields of the two groups were very similar, which confirms that there was no major difference between the groups in the overall ketosis picture. The feeding of an adequate level of minerals in this experiment did not result in any noticeable

reduction in the incidence of ketosis and some factor other than the apparent deficiency of minerals in the home-produced feeds was clearly present.

The prevalence of a sub-clinical ketosis without obvious clinical signs was indicated in this experiment and this condition may have a wider occurrence than is generally believed. Reports of dairy herds where diagnostic tests have been made confirm this sub-clinical level (Penny, 1958; Holmes, 1958). In normal farm practice where the milk of individual cows may be weighed only monthly and where no tests for ketone bodies are made, it is probable that most forms of this sub-clinical and even mild clinical ketosis would exist undetected.

It appears, therefore, that a greater understanding of the factors involved in this sub-clinical ketosis is desirable and further work to investigate some nutritional aspects of the problem is planned.

SUMMARY

Seventeen Ayrshire cows which had completed an average of 5·4 lactations were divided into two groups containing eight and nine cows, balanced for age, date of calving, live weight and milk yield.

The cows in both groups were fed a basic ration of 30 lb. grass silage, 20 lb. fodder-beet and 9 lb. dried grass daily, from three weeks before calving to the end of the experiment.

In addition one group received a high mineral concentrate whereas the other group was fed a low mineral concentrate which contained less than the recommended levels of some elements. The concentrates were fed at the rate of 4 lb. per 10 lb. milk for both groups.

The mean levels of ketone bodies in the blood, expressed as mg. acetone per 100 ml., were 10·6 and 11·7 for the high and low mineral groups respectively, before calving, and 13·4 and 13·6 mg. after calving. On the classification of the blood values (Thin & Robertson, 1953) there were six cases of ketosis in the high mineral concentrate group and eight cases in the low mineral concentrate group.

In the high mineral group there were 72 samples of milk positive to Rothera's test, compared with 74 in the low mineral group, but the latter group contained a higher proportion of samples which gave +3 and +4 reactions.

Milk yields, live-weight changes and clinical symptoms were all very similar in both groups of cows.

It is concluded that there was some factor other than the mineral composition of the diet which was responsible for the high incidence of mild and sub-clinical ketosis in both groups of cows.

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DISEASE OF THE LIGAMENTUM NUCHAE ASSOCIATED WITH *BRUCELLA ABORTUS* INFECTION IN THE HORSE, AND ITS TREATMENT WITH STRAIN 19 VACCINE

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In discussing fistulous withers or nuchal disease in the horse, Duff (1936) says that of the many factors which have been considered from the point of view of aetiology, trauma and pyogenic bacteria have been implicated most frequently. In addition, studies of abnormalities of the ligamentum nuchae of the horse by Bovett (1861), Railliet & Henry (1910), Robson (1918), Van Volkenburg (1921), Caslick (1921), Ackert & O'Neal (1930), and Pillers (1931) have shown that *Onchocerca cervicalis* is very often associated with these conditions. No statistics appear to be available to indicate the frequency with which this parasite can be found in apparently normal horses. Bacteriological examinations of material from the affected tissues have demonstrated also that *Brucella abortus* alone or accompanied by other organisms may be associated with such lesions.

The possibility of *Br. abortus* being associated with abortion in mares was demonstrated in America by McNutt & Murray (1924), who isolated the organism from an aborted equine foetus. As a result of this discovery work was undertaken in Minnesota on *Br. abortus* infection in horses by Fitch, Delez & Boyd (1930). Of 46 horses suffering from poll evil and fistulous withers which were placed under observation, 40 gave positive reactions to the agglutination test. *Brucella abortus* was recovered from samples of pus from three out of 24 affected horses. In later studies at the same laboratory, agglutinins were found in 76 per cent of the horses tested (Fitch, Bishop & Boyd, 1932). The organism was isolated from 22 per cent of the specimens of pus examined. Five attempts were made to infect horses experimentally. In one case a condition indistinguishable from poll evil was set up when a suspension of *Br. abortus* was injected between the portions of the ligamentum nuchae at the poll. Agglutinins at a titre of one in 1,000 were demonstrated in the blood serum two months after inoculation, and *Br. abortus* was recovered from the lesion.

Steward (1935) reported on the vaccine treatment of 68 horses. Of these 52 (76 per cent) recovered. Surgical intervention was employed on 19. Of the 16 which did not recover, six showed no improvement, seven showed improvement, two were destroyed and one died from other causes. Steward mentions one disagreeable feature of the vaccine treatment: it produces a fairly severe reaction in infected horses. This would seem to be in the nature of a reaction

to infection, as when the vaccine was inoculated into horses showing no agglutinins to *Br. abortus* the reactions were negligible.

Steward (1935) quotes figures indicating firstly that *Br. abortus* is associated more frequently with cases of fistulous withers and poll evil than is generally believed, secondly that a very high percentage of the affected horses have been in contact with cattle, and thirdly that a vaccine prepared from *Br. abortus* is reasonably effective in assisting the healing of these lesions.

Steward says also that in considering the aetiology of equine nuchal disease the geographical and local distribution and peculiarities in the occurrence of the condition may be important. For instance, if *Onchocerca* is of primary importance the occurrence of the vector (*Culicoides* spp.) will be of obvious moment. Scott (1917) stated that he had seen only one case on upland farms to ten or twenty on low marshland and it is possible that this might be explained by the distribution of the midge (*Culicoides nubeculosus*). The occurrence of the disease particularly in farm horses, and its relative rarity in hunters and ponies, might be explained by the association of farm horses with the farmyard during the summer when the vectors are prevalent.

Karlston & Boyd (1940) describe five horses that reacted to the agglutination test for *Br. abortus* infection and which were studied by bacteriological examination of blood, urine and faeces. Complete necropsies were made on each animal and various tissues were examined for the presence of *Br. abortus*, which was isolated from the faeces of two. Another horse developed an abscess on the withers from which *Br. abortus* was recovered. The organism was isolated from a lesion in the sternum of a fourth horse and from lesions in the ribs of a fifth. It could not be demonstrated in the blood stream or urine of any of the horses.

The cases of four horses treated with strain 19 vaccine (Buck, 1930) are reported here.

CLINICAL REPORTS

Case I was a three-year-old cart gelding which had been in its owner's possession for 12 months and of which the previous history could not be obtained. For six months the animal had shown an extensive swelling on its withers which had burst on several occasions and been treated by the owner with "farmyard remedies". During the time the animal was affected it was unable to trot or gallop and could only feed with difficulty. The serum was positive to the agglutination test for *Br. abortus*.

The gelding was treated with 8 ml. strain 19 vaccine at ten-day intervals, on three occasions. Severe local and general reactions were described by the owner, who had been previously warned of their probable occurrence. As the inoculation sites healed the fistulous withers receded and the horse was at work in a collar within 16 weeks. There was no recurrence during a period of 2½ years.

Case II was a child's pony, eight years old, which had had fistulous withers for two years. The lesion had varied in size and acuteness and had been

opened surgically once. The pony was grazed with cattle which had reacted to *Br. abortus* agglutination tests. The pony also reacted to the agglutination test.

Five ml. strain 19 vaccine was injected on three occasions at ten-day intervals. Local and general reactions were less severe than anticipated. The fistulous withers receded. There was a slight recurrence on one occasion, but resolution took place without any treatment.

Case III was a four-year-old thoroughbred filly which had had bilateral fistulous withers for six months in which the lesions ruptured to the surface persistently. The filly became affected during an acute brucellosis "storm" in the dairy herd. Five cows and the filly all reacted to the serum agglutination test for *Br. abortus* at the same time.

The filly was vaccinated on three occasions with 6 ml. strain 19 vaccine at ten-day intervals. Marked reactions occurred at the site of inoculation. As these abated the fistulous withers resolved.

Case IV was an eight-year-old pony mare the history of which could not be traced. This mare had had bilateral fistulous withers and had been affected for fifteen months.

She was positive to the serum agglutination test against *Br. abortus* and was treated three times, at intervals of ten days, with 8 ml. strain 19 vaccine. There was a slight reaction at the site of the inoculation, and the lesions on the withers resolved. Eight months later she was still normal but the time lapse has been insufficient to know positively whether this is permanent.

DISCUSSION

The literature gives a considerable amount of support for the view that *Br. abortus* is aetiologically involved in poll evil and nuchal disease or fistulous withers in the horse.

Steward (1935) describes the use of a vaccine in the successful treatment of many cases. No reference is made to the preparation of the vaccine or its composition.

Steward (1935) says that one disagreeable feature of vaccine use is the severe reaction in infected horses. He stated that when his vaccine was injected into horses which did not react to the *Brucella abortus* agglutination test, hardly any reaction was shown at the site of inoculation. This appears to be the case also when strain 19 is used. The longer-standing and the less acute the state of the lesion, the less is the local reaction to the vaccine. Although long-standing chronic cases react in a much less severe way, the response to the treatment seems equally good.

In two of the cases recorded here there was no history of any probable source of their infection. The other two were in close contact with cows infected with *Br. abortus*. Such association has also been noted previously. It would be interesting to obtain the results of agglutination tests of any other in-contact horses in these areas, to see if they give a positive reaction.

When strain 19 vaccine was used in the treatment described above, the inoculation sites on the neck were varied in anticipation of the reaction. The doses of the vaccine varied from 5 to 8 ml. according to the size of the horses. The time between the injections was based on Steward's (1935) original timing. It is felt that the local reaction must have influenced this timing in many cases, for it would be injudicious to administer a second dose before there was recovery from the first.

It would seem from the results described here that the use of strain 19 vaccine may be of value in those horses with disease of the ligamentum nuchae which react to the *Br. abortus* agglutination test, though it should be borne in mind that some may show rather severe local reactions to injection of the vaccine. This reaction is temporary and is a justifiable risk because of the chance of recovery from fistulous withers and poll evil when the hope of success with other methods is not very great.

SUMMARY

The treatment of four cases of fistulous withers with *Brucella abortus* strain 19 vaccine is reported. The local reaction at the vaccination site was severe but subsided and the whole condition resolved.

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THE VETERINARY SURGEON AT HORSE SHOWS AND AT POLO CLUBS

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It may not be generally appreciated that veterinary services are a most important part of all meetings, shows and tournaments, where animals are exhibited or employed. Each type of show or sport presents its own particular problems to the veterinary surgeon, and they are here considered in relation to showing and polo.

HORSE SHOWS

The duties and responsibilities of the veterinary surgeon are broadly to deal with cases of injury or sickness, to act in an advisory capacity to the Show Committee, judges and stewards, and to measure animals entered in classes for which there is a height restriction.

Prior to the show a meeting should be held with the Secretary or a representative of the Show Committee to ensure that the necessary facilities will be provided for the veterinary surgeon to enable him to carry out his duties, and he should explain his requirements. These will depend to some extent on the size, type and duration of the show, which may vary from the one-day local event to the major shows of several days' duration which are sometimes held on a permanent show site.

Equipment and Accommodation

For the small events the veterinary surgeon usually takes his own equipment and first-aid kit in his car, which is parked at a convenient site on the show ground and serves as office and surgery.

At the larger shows it is advisable to make more elaborate arrangements and the following requirements should be considered:

A small tent or office if permanent buildings exist, should be provided, and plainly designated, for the veterinary surgeon; a suitable level site or platform for measuring; and a proper horse ambulance which should be in attendance and at the disposal of the veterinary surgeon at all times.

As regards equipment, the veterinary surgeon will usually bring his own instruments and drugs, sufficient to enable him to carry out any necessary first-aid treatment. At some shows supplies of cotton wool, bandages and disinfectant will be provided, but the veterinary surgeon will normally have his own dressings available. A humane killer is essential, and a twitch will

be found useful where small operations such as suturing wounds have to be carried out.

Organization on the Show Ground

On arrival at the show ground, the veterinary surgeon should get in touch with the Secretary or his assistants and tell them whereabouts on the show ground he can be found if required. If it is necessary for him to leave the show ground, or when he is going for lunch or tea, the Secretary's office should be informed. At practically all shows there will be a loudspeaker system, and it is customary for the veterinary surgeons and doctors to be called for by the commentator or announcer when required. It is very annoying, and bad publicity, to hear repeated calls for the veterinary surgeon long after he has reached the casualty and is attending to it. This can be avoided if there is good liaison with the Secretary's office and the announcer. When there is more than one veterinary surgeon present, the periods of duty can be arranged by rota, so that there is always one immediately available in case of accidents.

The Management of Casualties

When casualties occur action should be confined to such first aid or treatment as is necessary for the immediate welfare of the animal, and to enable the owner to get it home or to some other safe place. If subsequent treatment is required, the owner should be told to contact his own veterinary surgeon as soon as possible, and advice may be given on the care and precautions necessary in the meantime. Where such treatment as the administration of tetanus antitoxin is indicated, the owner or his representative should be so informed.

When serious accidents occur and destruction of an animal is necessary, the permission of the owner or his appointed agent must be obtained. Should immediate destruction be essential and the owner or his representative not be available, the present law is that a police constable can give a veterinary surgeon authority to destroy an animal on humane grounds. In these cases of accident, it is essential to get to the spot as quickly as possible, but at the same time not to be panicked into hasty decisions, or be influenced in any way by gratuitous advice from onlookers, owners or show officials. It is the veterinary surgeon alone who has to make the final decision and bear the responsibility if a mistake occurs, and who will have to sign the certificate when an insurance claim follows. Actions at law may result, so he is entitled to take a reasonable time over examination and diagnosis especially when there is no obvious or gross injury.

Lameness in the Show Ring

On occasions, the veterinary surgeon may be requested by the judges to enter the ring and give an opinion on whether an animal is lame. It is only necessary to give a simple answer—either the horse is lame or not lame, and a diagnosis regarding the cause of the lameness is not required. If a horse is eliminated from the class for lameness, the owner or his agent may well ask

for an opinion as to the cause. Where an immediate diagnosis is possible there is no reason why the owner should not be given an opinion, but it is generally wise to advise him to consult his own veterinary surgeon. The opinion should be regarded as confidential to the owner and the question of soundness or unsoundness should not be discussed with any other person. An indiscreet word regarding the soundness or otherwise of a show animal might possibly prejudice a sale at some later date.

If the judges should ask the veterinary surgeon's opinion on a particular point of soundness, he is entitled to give his opinion to the judges only and it should be regarded as confidential. The judges are themselves responsible for assessing conformation and action.

Measurement of Horses and Ponies

Certain show classes are subject to a maximum height restriction and it is the duty of the veterinary surgeon to measure the entries to ensure that they come within the height limit of the class for which they are entered. It is desirable to arrange with the show executive for horses and ponies to be presented for measuring at least an hour before judging of the class in which they are entered is due to begin. If there is a very large entry, more than an hour may be required.

If the animal does not come within the prescribed limit, the Committee or Secretary should be informed accordingly, before the class enters the ring and judging commences.

It is the responsibility of the veterinary surgeon to ensure that the measuring standard he uses is an accurate one. It should be shod with a metal plate at the bottom of the stick and must be fitted with a spirit level. If there is no measuring platform a hard level area or a level section of road should be selected. An allowance of half-an-inch is made for normal shoes, but no allowance for tips, plates or charlier shoes.

In order to reduce the amount of measuring at shows, a Joint Measurement Scheme for Ponies, Hacks, Cobs and Jumping Ponies has been adopted under the auspices of a number of horse societies and associations. A panel of official measurers, all of whom are veterinary surgeons, is appointed annually to cover the whole of England, Wales and Scotland. Two types of certificate are issued: (a) life certificates for horses or ponies six years old and over; and (b) annual certificates for horses or ponies under six years.

When a horse or pony with such a height certificate is presented the veterinary surgeon is not required to measure the animal and in fact should not do so. He is required only to check the description of the animal against the certificate, to ensure that it is a current certificate and that the name on the certificate corresponds with the show entry.

In the event of an objection, on a question of height, to a horse or pony possessing a Joint Measurement Scheme certificate, subject to the procedure laid down, the animal may be re-measured by two referees nominated by the Royal College of Veterinary Surgeons, who have a panel of referees appointed

for this purpose. The veterinary surgeon at a show cannot himself take any action if there is an objection under the Scheme.

POLO CLUBS

All that has been said in connection with horse shows regarding the duties of the veterinary surgeon and his relationship with owners applies equally at polo tournaments. Practitioners will, however, frequently be dealing with their own clients if they are the appointed veterinary surgeon to the club.

Casualties

Since polo is played at a fast pace, the number of accidents and injuries occurring will be greater than at shows, and the arrangements for dealing with them demand thorough organization in conjunction with the Secretary and Polo Manager. The veterinary surgeon must be in attendance all the time that play is in progress, so that he is immediately available if a casualty occurs. If he is watching the game, he will himself see when he is required and forestall shouted requests from umpires or players for the veterinary surgeon, or urgent calls over the loudspeaker.

It is convenient to have a car close to the pony lines with dressings and equipment, and parked so that it can be driven straight on to the ground, which may be desirable if an accident occurs at the far end of the ground. The spectacle of the veterinary surgeon or other officials running on to the ground when a mishap occurs tends to give an undesirable impression of emergency. On the other hand, the immediate appearance of a car which rapidly reaches any part of the ground lends an appearance of organized efficiency without flurry. The post-war revival of polo in this country has attracted the attention of the general public and very large crowds of spectators are commonplace, in addition to which some tournaments are now televised. It is therefore important that the veterinary arrangements should at all times be efficiently organized.

During intervals, the veterinary surgeon should visit the pony lines so that he is available to advise or help with any problems or minor casualties. Such visits will save messengers being sent to look for him, or repeated calls over the loudspeaker. When the same veterinary surgeon is regularly employed by a club, the officials, players and grooms will get to know his routine and where they can expect to find him.

When asked to attend at polo clubs in a professional capacity, whether as a paid or honorary official, the facilities which the veterinary surgeon requires should be made clear to the Secretary or Committee. A horse ambulance must be provided and placed at his disposal, and it is also advisable in case of fatal accidents to have a van with a mechanical loading device. Canvas screens, of the type now used on racecourses, should be provided in case it is necessary to destroy a pony in the presence of the spectators. Permission to destroy a pony must be sought from the owner in the usual way.

(*Received for publication*, 2 *February*, 1961)

BOOK REVIEWS

Slaughterhouses. By Paul Sieghart and J. B. Whaley. London: Sweet and Maxwell. Price £2 10s.

The laws relating to the supply of meat to the public, and to slaughterhouses and operations connected therewith, have been enacted piecemeal over the years. Wartime controls caused a break in the flow of legislation but since the war many important enactments have appeared on the Statute Book which vitally affect the construction and operation of slaughterhouses and the handling of food animals before and after slaughter. The complex nature of the various enactments has produced a tangle of legislation through which even the trained mind finds it difficult to see the light.

In this book the authors, both barristers-at-law, have endeavoured to resolve the problem and have succeeded in collecting current legislation between the covers of one volume—a satisfactory accomplishment in itself. They set out to classify the law, as governed by the various statutes and regulations, in an orderly yet comprehensive manner.

Part I deals with the law relating to slaughterhouses, Part II is devoted to licensing procedure, Part III to the slaughter of animals, Part IV to slaughterhouse practice and Part V to safety, health and welfare of workers in the slaughtering industry.

The appendices contain copious extracts from the various statutes and regulations and a useful list of local authorities where resolutions under sections 75 and 76 of the Food and Drugs Act, 1955, are currently in force.

For the first time, therefore, the whole of the law applicable to the industry is gathered together, and easily accessible.

The inclusion of opinion as to the interpretation of the law is inevitable in a book of this kind and the reader may not always find himself in total agreement with the interpretations offered. In every case, however, the book indicates, by footnote or reference, the actual section of the legislation concerned so that direct access to the relative section is a simple matter.

There is no doubt that this book will be a most useful and helpful work for local authority officials, meat traders and their advisers, slaughterhouse operators, and, in fact, all those connected with the slaughter of animals for human consumption.

It is a matter for regret that the book did not appear earlier as time is running out on some of the provisions of the Slaughterhouses Act, 1958. Nevertheless there is still much in it that is useful to all concerned and it will stand as a useful work of reference for a long time to come.

George Tullis

Nitrous Oxide in Dentistry—Its Danger and Alternatives. By J. G. Bourne. London: Lloyd Luke. Price 30s.

This book is written primarily for the dental surgeon and the medical practitioner who requires short anaesthesia in the treatment of outpatients. It contains much information that is of interest to the veterinary surgeon and

scientist. It is the result of a number of years of investigation and research by the author into the reasons for the occasional unsatisfactory result or mishap that occurs when nitrous oxide, which is widely used for outpatients, is so employed. He shows that it is in the main due to the weak anaesthetic properties of nitrous oxide, and the consequent employment of low oxgyen tensions with it. This leads to hypoxia which, should a sudden fall in blood pressure occur (such as in an undetected faint) may lead to serious brain damage. After discussing ways and means of overcoming these dangers with nitrous oxide, the author then advocates approaching the problem of short (outpatient) anaesthesia from a fresh angle. He describes in some detail the way in which inhalation anaesthetic agents are taken up by the body, and he goes on to examine the possibilities of using the other inhalation anaesthetics and the short-acting barbiturates for this purpose. He reaches the conclusion that cyclopropane is not only the most suitable alternative, but a considerably superior agent.

In the later chapters of the book, the pharmacology of cyclopropane is discussed in detail and illustrated by reference to experimental work in animals. Many misconceptions regarding it are corrected and explained, and its clinical suitability is proved by the results of some 3,000 anaesthesias. Its rapid absorption and elimination, intermediate potency and comparative freedom from toxic side-effects, together with the fact that adequate oxygenation is possible at all times, make it one of the most suitable agents for short anaesthesias from which rapid recovery is essential. When the gas is mixed with the correct proportions of oxygen and nitrogen the danger of explosion is eliminated. The author describes an ingenious little apparatus which can be carried in the bag or pocket, with the gas supplies compressed into a pair of small bulbs, thus making its use feasible anywhere. The apparatus and method have been subjected to a limited veterinary field trial with very satisfactory results. It should prove of interest to the veterinary surgeon requiring short anaesthesias with quick recovery, without recourse to more complicated, cumbersome and expensive methods.

A. G. WARREN

NEWS

UNIVERSITY OF BRISTOL
SYMPOSIUM ON ANIMAL HEALTH AND PRODUCTION

The Colston Research Society, which for many years has made grants in aid of research in the University of Bristol has since 1948 arranged annual Symposia on subjects appropriate to the various University departments. The purpose of the Society in sponsoring these symposia is to bring together, for the reading of papers and for discussions, groups of experts in any field chosen from the whole range of the arts and sciences, where research is active. Freedom of choice of subjects gives the Society a much wider scope than that of learned bodies arranging similar gatherings.

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The symposium for 1961, from April 10th to 13th, arranged by the Veterinary School, has an all-embracing title. The choice of title is deliberate and arises from the conviction that a useful purpose will be served by bringing together workers in different branches of research relating to farm livestock, especially as it is probably true to say that similar opportunities for meeting and discussion arise seldom if at all.

The development of more and more intensive production methods in animal husbandry is throwing up complex problems. The symposium will be looking at some of these problems, the different techniques used in attempting their solution, and the successes which have been achieved.

Membership of the Symposium is limited and the papers read, with the discussions, will be published as Volume XIII of the Colston Papers.

PROVISIONAL PROGRAMME

Sir John Ritchie, Chief Veterinary Officer, Ministry of Agriculture, Fisheries and Food and President of the Royal College of Veterinary Surgeons, has accepted the Society's invitation to give an address at the Society's Annual Reception on the evening of Wednesday, the 12th April, 1961.

The following have accepted invitations to give papers:

S. J. Bach (Reader in Chemical Physiology, University of Bristol): "Biochemical Aspects of Bovine Ketosis".

P. M. Biggs (Principal Scientific Officer, Houghton Poultry Research Station): "Observation on the Cells from the Lesions of Lymphoid Leukosis and Fowl Paralysis".

J. J. Bullen (Head of Pathology Department, Rowett Research Institute): "Bacteriostatic Properties of Sera and Immunity to Gas Gangrene Infections".

B. R. Burmester (Biologist, Regional Poultry Research Laboratory, East Lansing, Michigan): "Experimental Transmission of Visceral Lymphomatosis and Related Neoplasms".

J. G. Campbell (British Empire Cancer Campaign Unit, Poultry Research Centre, Edinburgh): "A Proposed Classification of the Leukosis Complex and Fowl Paralysis".

Th. de Groot (Laboratory of Animal Physiology, Landbouwhogeschool, Wageningen, Netherlands): "Magnesium Intake and Utilization".

A. W. Gledhill (National Institute for Medical Research, Mill Hill): "Non-specific Resistance to Infectious Diseases".

G. Peeters (Professor of Physiology, Veeartsenijschool, Ghent): "Some Aspects of Bovine Ketosis".

A. T. Phillipson (Deputy Director, Rowett Research Institute) with A. Dobson (Physiology Department, Rowett Research Institute): "Individuality and the Effect of Early Summer Grazing on Ruminants".

A. E. Pierce (Principal Scientific Officer, Institute of Animal Physiology, Babraham): "Antigens and Antibodies in the Newly Born".

S. E. Piercy (Wellcome Research Laboratories, Beckenham): "Recent Progress in the Development of Living Viral Vaccines".

E. J. L. Soulsby (Department of Animal Pathology, University of Cambridge): "Immunity to Helminths and its Effect on Helminth Infections".

FOOT-AND-MOUTH DISEASE

Inoculation of Cattle

In reply to a recent question in the House of Lords Lord Waldegrave, Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food said that vaccination against foot-and-mouth disease had long been practised in South America and also in other parts of the world where the disease was endemic, or enzootic, and widespread. Information about the methods used

was given in Chapter III of the Report of the Departmental Committee on Foot-and-Mouth Disease published in 1954 (the Gowers Committee).

The Minister of Agriculture was familiar with the situation in the South American countries and three veterinary officers were permanently stationed there to assist the authorities in dealing with foot-and-mouth disease, particularly in the context of the fulfilment of the Bledisloe Agreement, which regulated the transit and inspection of animals and carcases intended for export to this country. Recently, new measures had been introduced in the Argentine, which were welcomed as further steps towards the ultimate goal of eradication.

Vaccination against foot-and-mouth disease was *only* sound policy where there was so much disease that compulsory slaughter was impracticable. In our own country, which was an island, we were fortunate that the disease was *not* always with us. When an outbreak did occur in this country, by far the most effective way of dealing with it was to stamp it out by the compulsory slaughter of infected animals and dangerous contacts. The Departmental Committee, under the chairmanship of Sir Ernest Gowers, were emphatic that on economic grounds this was the right policy for this country.

Finally, Lord Waldegrave said, the European Commission for the Control of Foot-and-Mouth Disease, to which we belonged, had recommended that those member countries which were not yet in a position to use compulsory slaughter should seek, by vaccination and other control measures, to reduce the incidence of the disease to the point where a slaughter policy would become practicable. Nobody doubted the wisdom of this policy objective, which other countries, less fortunate than our own, were striving to attain.

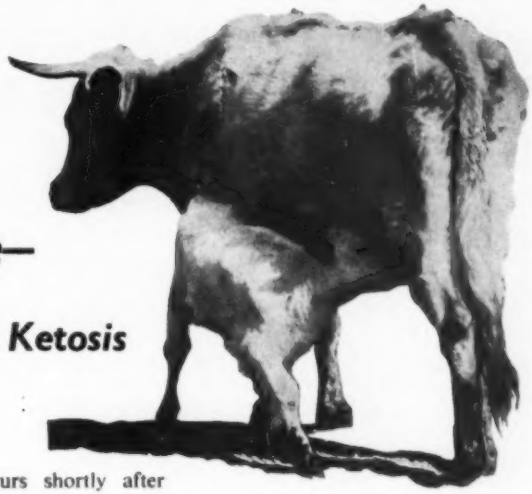
THE ZOOLOGICAL SOCIETY OF LONDON RESEARCH FELLOWSHIPS

In May 1960, the Ford Foundation made a grant of 550,000 dollars to the Zoological Society of London to endow three Senior Research Fellowships and three Junior Research Fellowships in animal reproduction.

The Council of the Society, advised by a Committee of eminent scientists, has appointed Dr. Peter A. Jewell, M.A., Ph.D., B.Sc., Dr. Lorna M. Kellas, B.Sc., Ph.D., and Mr. D. R. S. Kirby, B.Sc., to these Fellowships.

Dr. Peter A. Jewell, who will hold the appointment for five years, is at present working at the Royal Veterinary College and will take up his new appointment on 1st May, 1961. The subject of his study will be the breeding biology of Soay sheep, which are confined to the Island of St. Kilda, and which present unique material for the investigation of a population of small ungulates. He also intends to study the reproduction of various forms of *Apodemus* under laboratory conditions. Until suitable laboratory space is available at the Society's Gardens, Regent's Park, Dr. Jewell will work in the Department of Animal Husbandry and Veterinary Hygiene, the Royal Veterinary College, London.

Dr. L. M. Kellas, who is appointed for three years, at present holds an appointment in the Department of Veterinary Histology, University of Glasgow



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Reference : Shaw, J.C. (1955) Advances in Vet. Sci. *ii*, 262-360.
Huber, W. G. (1958) Vet. Med., *53*, 55.
Link, R.P. et al (1957) J. Amer. vet. med. Ass., *130*, 137.

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Veterinary School, and will take up her appointment with the Society on 1st June, 1961. Dr. Kellas will make a histological and histochemical study of the intra-epithelial granular cell which occurs in the placenta of ruminants. She will also study the reproductive tracts of the giraffe, having already obtained certain material for these studies while on field expeditions to Central Africa.

Mr. David R. S. Kirby has been appointed for a period of three years, with effect from 1st October, 1960. For the time being, Mr. Kirby will continue to work in the Department of Zoology and Comparative Anatomy in the University of Oxford. He will study the effects of abnormal environments on the development of the embryo, with particular reference to the inhibitory influence of the endometrium on the spread of the cells of the trophoblast.

Applications for the remaining Fellowships will be invited in the near future.

BICENTENARY OF THE NATIONAL VETERINARY SCHOOL, LYONS

The National Veterinary School at Lyon, the oldest veterinary school in the world, which was founded in 1762 by Claude Bourgelat, equerry to King Louis XV, will celebrate the bicentenary of its foundation on the 26 and 27 May, 1962.

CASH AWARDS TO DESIGNERS OF HUMANE TRAPS

Closing date for Receipt of Applications in respect of Humane Rabbit and Vermin Traps

It was announced on 8th November last that the Humane Traps Monetary Awards Panel was ready to consider applications for awards from inventors whose original designs have led to the development of humane traps. The closing date for the receipt of applications for awards in respect of rabbit or vermin traps is 30th April, 1961. No closing date has yet been fixed for applications for awards relating to humane fox traps.

Applications should be made on a form obtainable from the Secretary, Humane Traps Monetary Awards Panel, Ministry of Agriculture, Fisheries and Food, Government Buildings, Block "B", Hook Rise, Tolworth, Surbiton, Surrey.

The members of the Awards Panel are:

Mr. J. Scott Henderson, Q.C. (Chairman), Recorder of Portsmouth, a former member of the Advisory Committee on Myxomatosis and Chairman of the Committee on Cruelty to Wild Animals;

Mr. W. A. T. Matheson, F.C.S., a Chartered Accountant with Messrs. Finnie, Ross, Welch and Company, who represents Scottish interests;

Mr. R. B. Verney, Chairman of the Executive Committee and Deputy President of the Country Landowners' Association, member of the Advisory Council on Rabbit Clearance and Chairman of the Humane Traps Panel;

Mr. H. N. White (Secretary), who is in charge of the Ministry's Infestation Control Branch at Tolworth, Surrey.

Under the Pests Act, 1954, it is illegal to sell, use or possess any spring trap

that has not been approved by the Minister of Agriculture, Fisheries and Food, or by the Secretary of State for Scotland. Seven spring traps have been approved for use in Great Britain.

ADVERTISER'S ANNOUNCEMENT

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REFERENCES

Worden A. N. 1958 a. "The feeding of fresh and stored chick mashes containing cod liver oil". Journal of Agricultural Science, Volume 50, number 3, pages 340 and 343.

Worden A. N. 1958 b. "The feeding of cod liver oil to growing/fattening pigs". Journal of Agricultural Science. Volume 50, number 3, pages 344-345.

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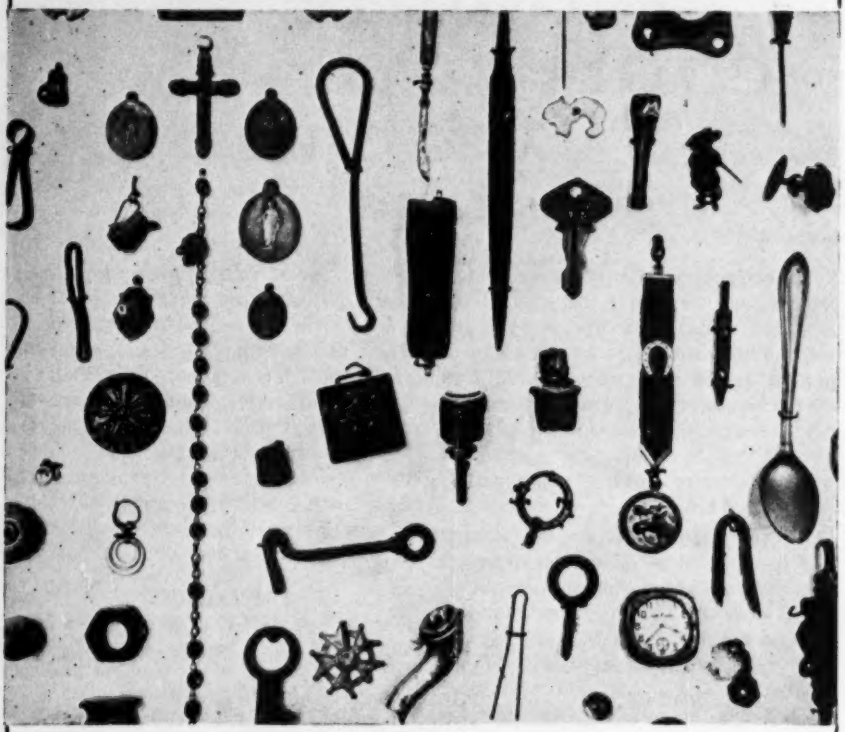

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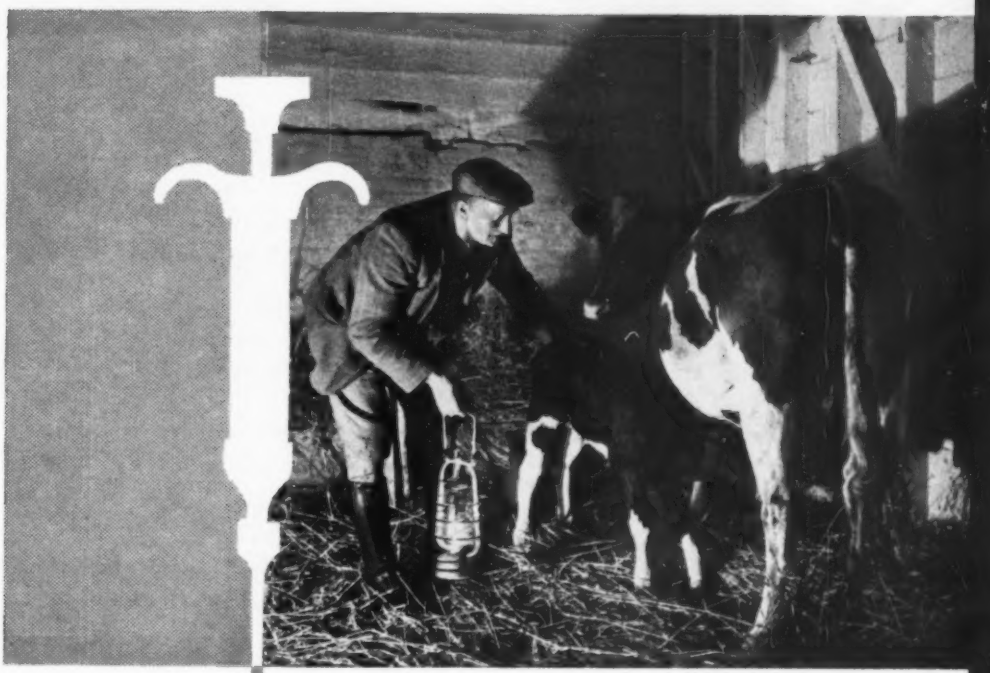

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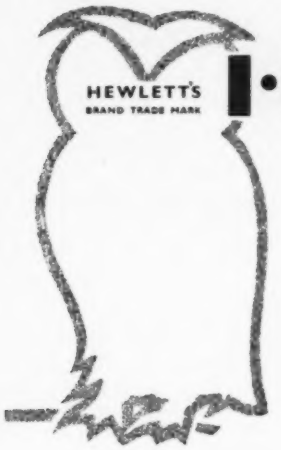

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J. O. L. King, *School of Veterinary Science, University of Liverpool.*	Effect of Environmental Temperature on the Growth Response of Chicks to an antibiotic supplement in the diet.
S. F. J. Hodgman, *The Canine Health Centre, Kennet.*	The Duties of a Veterinary Surgeon at Championship Dog Shows.
J. H. Aafjes & T. de Groot, *Laboratory of Animal Physiology, Wageningen, Holland.*	Creatinine in the Urine of the Dairy Cow.
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